Space Weather Technical Forecast

Issued on Saturday 22 March 2025 at 13:27 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-class flares. G1-G2 storms possible each day. Chance of G3 days 1 and 2 (22/23 Mar).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity reached Moderate levels following an isolated M1.2 flare at 21/1558UTC, from AR4028 in the southwest. There are currently fourteen sunspots on the Earth facing disc, twelve numbered and two un-numbered. Despite the large amount of sunspots, the vast majority are relatively small and magnetically simple and either stable or in slight decay. AR4036, near the meridian in the northwestern quadrant, is now the most significant group having displayed quite rapid growth in the past 24 hours. AR4026, AR4033 have faded to plage, with two simple new regions appearing in the eastern hemisphere near the limb.

A faint halo CME was observed from near centre disc following the M1.2 flare from AR4028 at 21/1558 UTC, with an expected arrival at Earth during the first half of 23 Mar, not other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1, were indicative of two to three CME enhancements. Speeds rose from slightly elevated to elevated, peaking around 560 km/s at 21/2200UTC, then fell back to slightly elevated to end the period. Density was around average or above. Interplanetary Magnetic Field, Bt, was initially moderate but became strong, peaking very strong around 40nT at 21/2100UTC, then fell back to Moderate. The north-south component, Bz, followed a similar pattern to the IMF, becoming strongly variable +33nT to -20nT before gradually easing. Phi angle was positive (away from the sun), then became negative (towards the sun) from 21/1600UTC. Geomagnetic activity started weak, with mostly G1/Minor Geomagnetic storms overnight, and a single G2/Moderate storm period at 22/0000-0300UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at background levels. High energy electron flux (greater than 2 MeV) was at background to moderate levels. The 24-hour fluence was below the Active threshold. The observed integrated pfu was 1.01e7 at 22/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low activity is expected, with a chance of further isolated M-class flares.

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Solar Wind / Geomagnetic Activity: Two CMEs feature in the forecast, with a chance of further weak transients. One CME from 19 Mar may give a glancing blow at Earth late on day 1 (22 Mar). The second was a faint halo CME which is likely to arrive during the the first half of day 2 (23 Mar).

Otherwise, solar winds are expected to continue slightly enhanced initially, CH24/- is expected to arrive during the first half of day 2 (23 Mar), bringing Enhanced solar winds, around 500-550km/s. Solar winds will then gradually decline through days 3 and 4, back to background before the potential arrival of the HSS from the large CH25/+ from late day 4.

Quiet to Active geomagnetic conditions are likely initially, before rising to G1/Minor to G3/Strong Geomagnetic storming in relation to the likely combined CH HSS and CME influence from late day 1 (22 Mar), through day 2 (23 Mar), with a greater risk of this expected day 2. Geomagnetic activity is then expected to reduce back to Unsettled to Active, with a chance of G1-G2/Minor to Moderate Geomagnetic Storms days 3 and 4 (Mar 24 & 25) from residual CME effects, then the HSS from CH25/+.

Energetic Particles / Solar Radiation: High energy proton flux is expected to be at background levels, with a slight chance of enhancement from any larger flares. High energy electron flux is expected to continue at largely background levels until later in the period, when it may become diurnally high. Electron (1e8 integrated pfu) fluence should remain below the Active threshold throughout the period, with a rising slight chance toward the end of the forecast.

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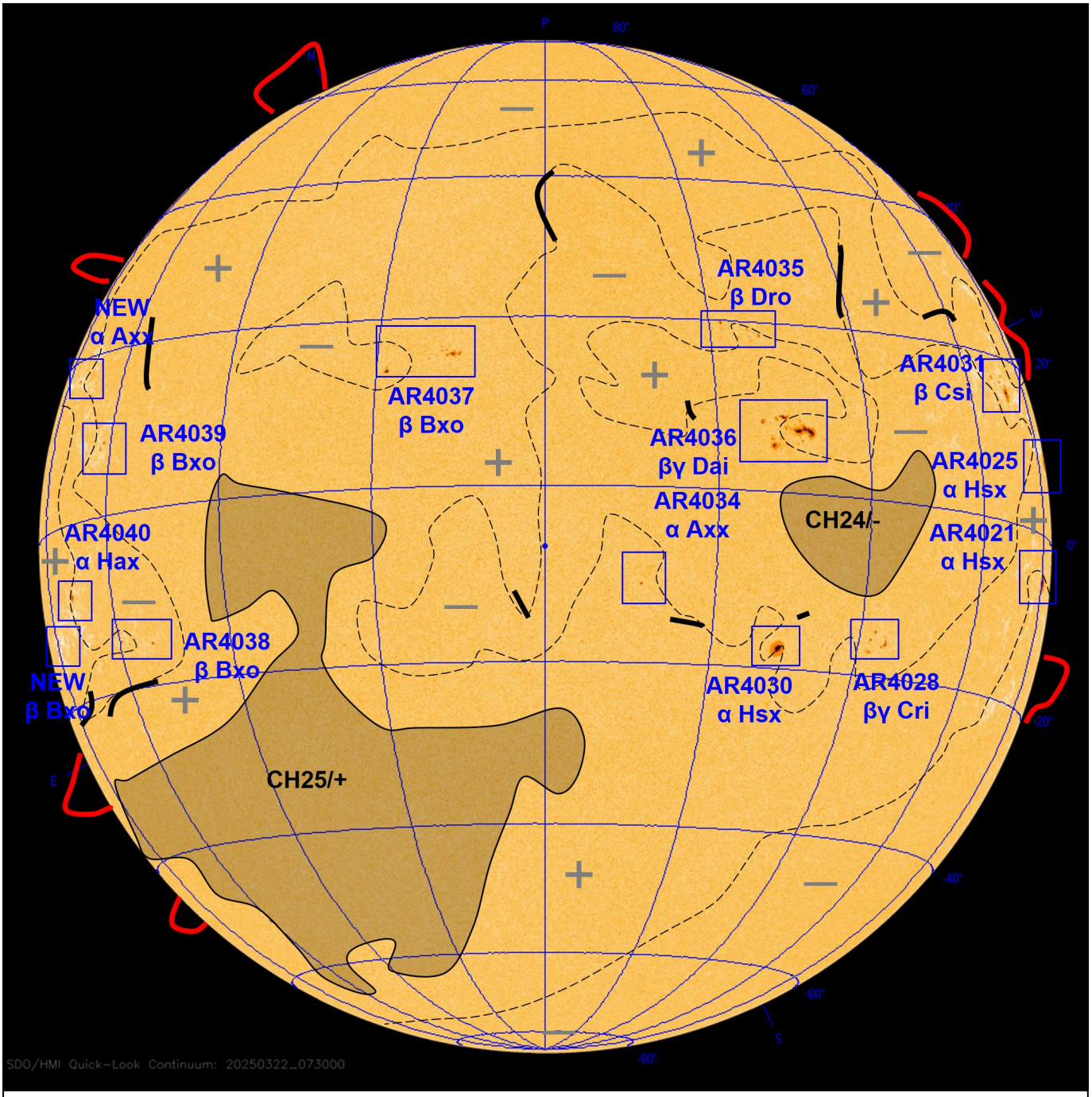
Figure 1: Solar Synoptic Map valid 22/0730UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are two distinct CMEs within the forecast period, with a chance of further weak transients which have not appeared on imagery. The first was observed leaving the Suns NE limb early on 19 Mar, possibly as a result of a filament eruption from the north-centre disc that occurred around 19/0034 UTC. ENLIL suggests a potential glancing blow at Earth late on day 1 (22 Mar). The second was a faint halo CME which was observed from near centre disc following the M1.2 flare from AR4028 at 21/1558 UTC. This has been analysed as a fast CME with speeds in the region 1000-1500km/s as it left the Sun, and is likely to arrive at Earth during the first half of day 2 (23 Mar) bringing solar winds speeds at L1 of 600-750 km/s. Given these potential CME influences, confidence in the forecast is lower than usual.

Otherwise, solar winds are expected to continue slightly enhanced initially, CH24/- is expected to arrive during the first half of day 2 (23 Mar), bringing Enhanced solar winds, around 500-550km/s. Solar winds will then gradually decline through days 3 and 4, back to background before the potential arrival of the HSS from the large CH25/+ from late day 4 as it becomes geoeffective.

Quiet to Active geomagnetic conditions are likely initially, before rising to G1/Minor to G3/Strong Geomagnetic storming in relation to the likely combined CH HSS and CME influence from late day 1 (22 Mar), through day 2 (23 Mar), with a greater risk of this expected day 2. Geomagnetic activity is then expected to reduce back to Unsettled to Active, with a chance of G1-G2/Minor to Moderate Geomagnetic Storms days 3 and 4 (Mar 24 & 25) from residual CME effects, then the HSS from CH25/+.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	Yes	60	90	50	40
Strong	**G3**	No	20	50	5	5
Severe	**G4**	No	5	20	1	1
Extreme	**G5**	No	1	2	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
19/1121	Partial	Filament Eruption	North-centre	635	22/1900	Glancing blow from shock possible.
21/1830	Full Halo	M1.2/Filament	Centre	1200	23/0600	Faint so unlikely to be material-rich, but fast and possibly enhancing already fast winds and disturbed near earth environment.

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Figure 2: MOSWOC Enlil showing the arrival of combined CME and CH HSS at 1AU during 23 Mar.

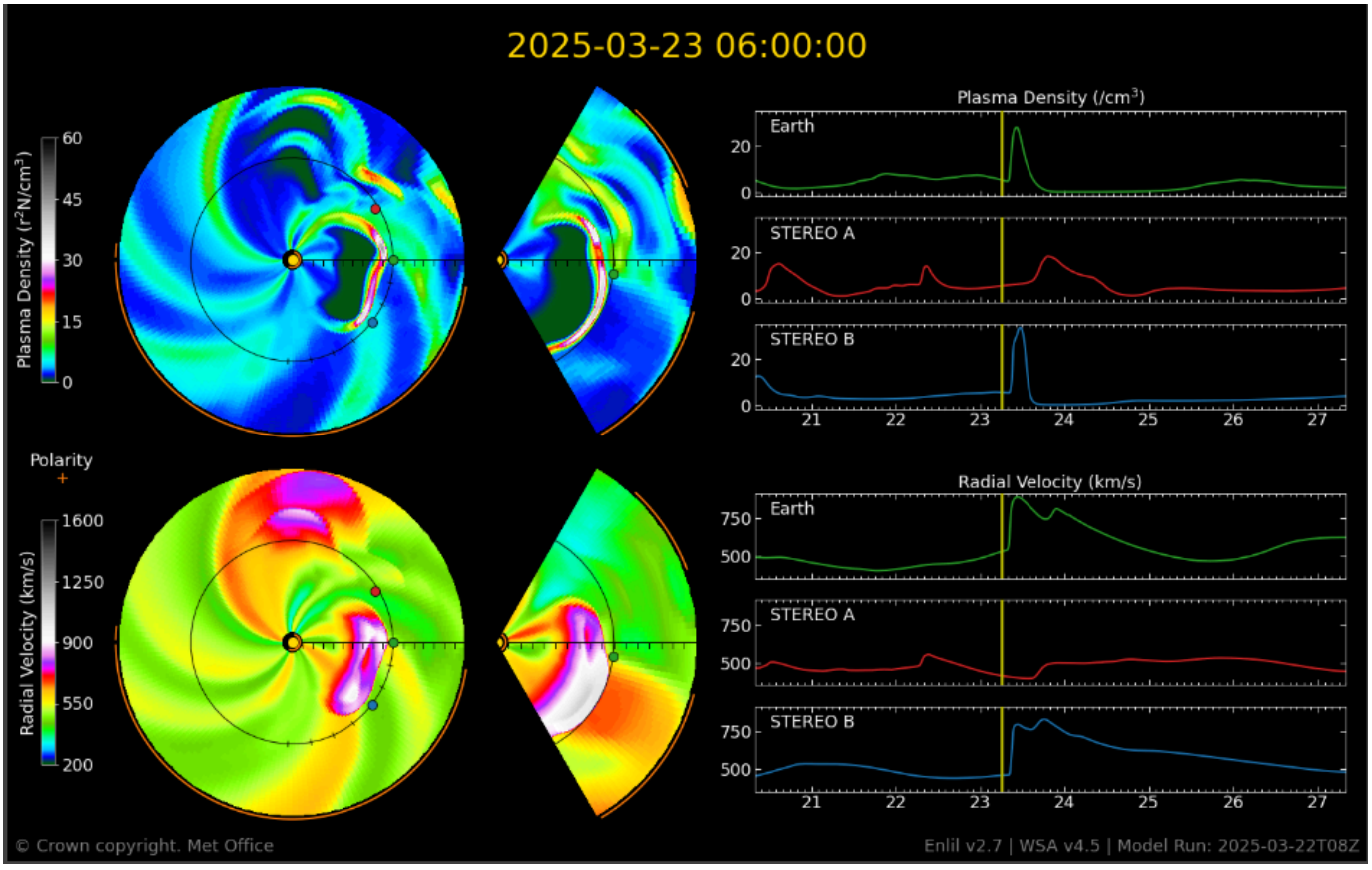
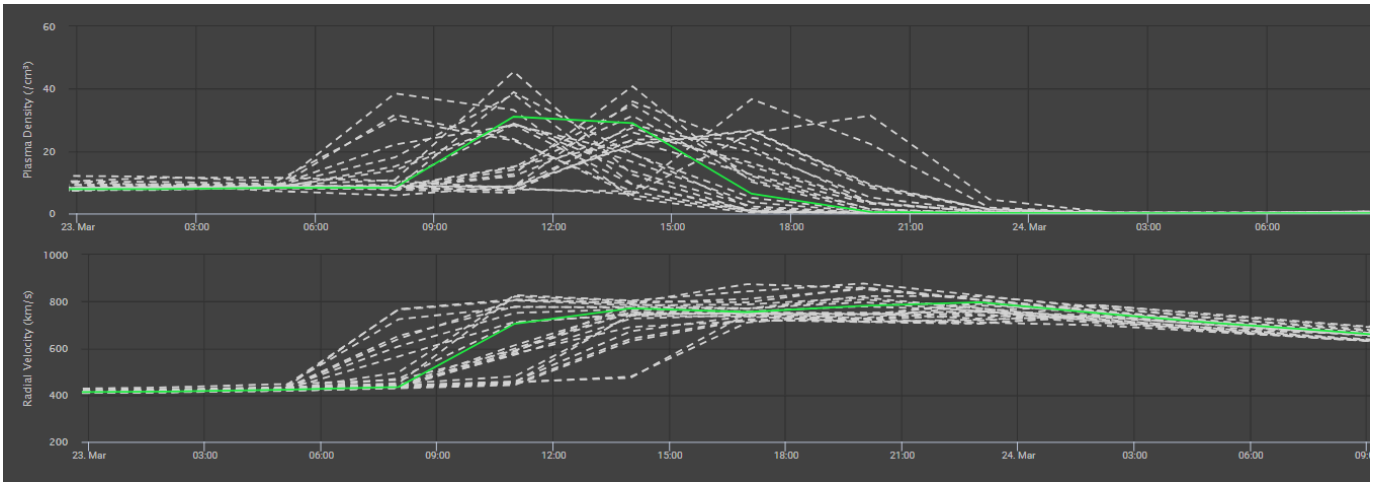


Figure 3: MOSWOC ENLIL ensemble.



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Radio Blackouts - X-Ray Flares

Solar activity reached Moderate levels following an isolated M1.2 flare at 21/1558UTC, from AR4028 in the southwest.

There are currently fourteen sunspots on the Earth facing disc, twelve numbered and two un-numbered. Despite the large amount of sunspots, the vast majority are relatively small and magnetically simple and either stable or in slight decay. AR4036, near the meridian in the northwestern quadrant, is now the most significant group having displayed quite rapid growth in the past 24 hours. AR4026, AR4033 have faded to plage, with two simple NEW regions appearing in the eastern hemisphere near the limb.

Generally Low activity is expected, with a chance of further isolated M-class flares, on a generally flat rend through the next 4 days.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	35	35	35	35
Very Active	R3-R5 (X Class)	No	1	1	1	1

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Figure 4: 24 hour X-ray trace.

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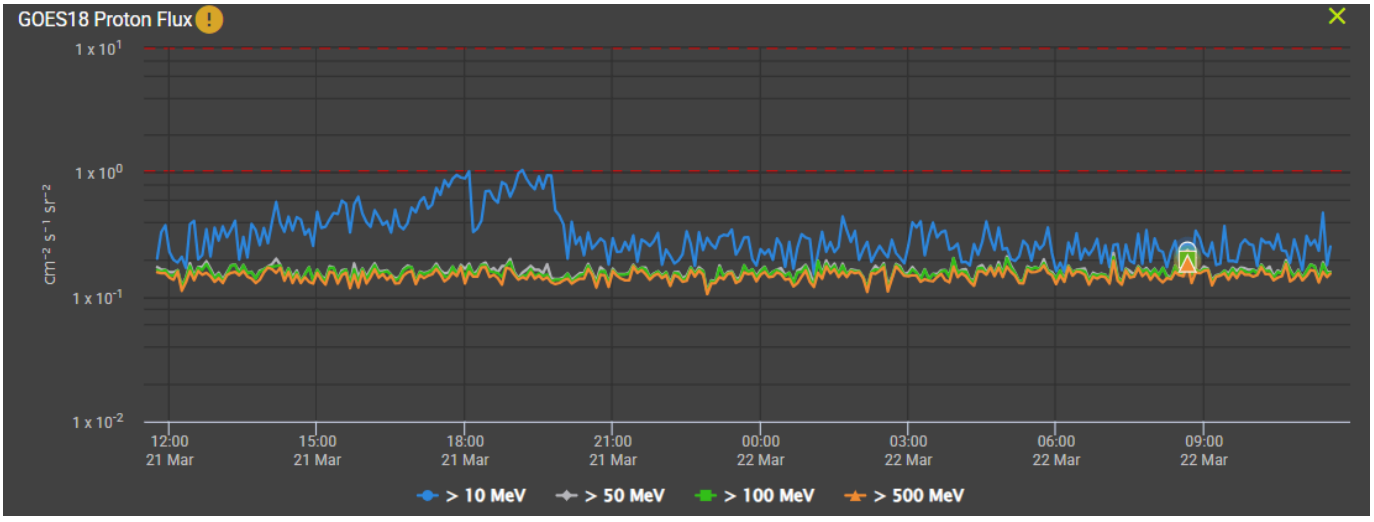
Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux has now returned to background levels after a slight enhancement which coincided with the M1.2 flare on 21 Mar. Proton flux is expected to remain at background levels, with only a slight chance of enhancement due to the current lack of large, complex spot groups on the Earth facing disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: 24 hour Proton trace.



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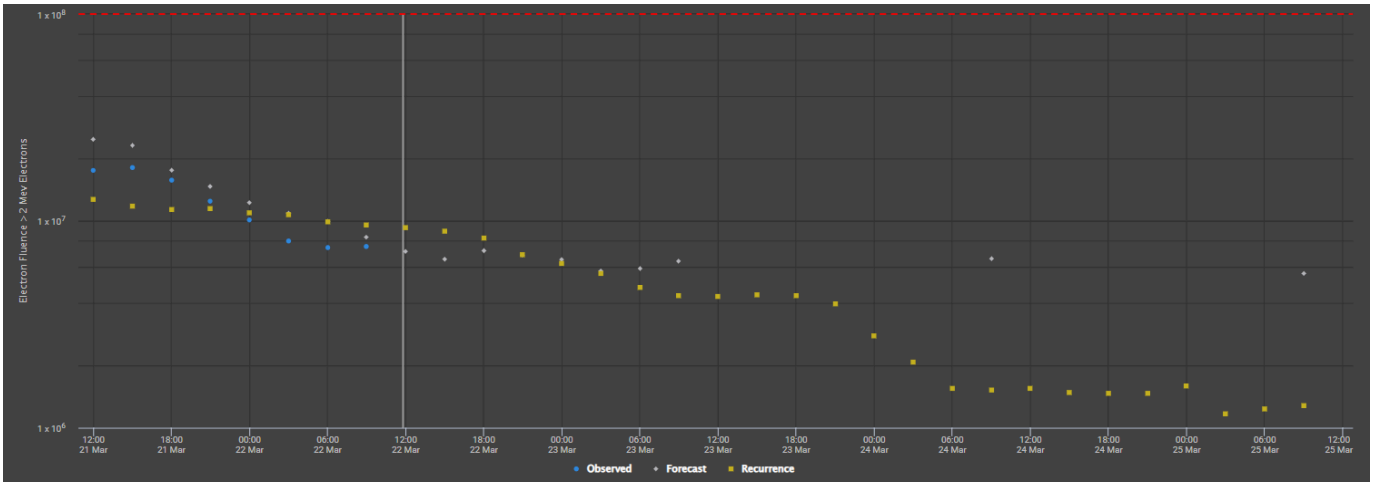
High Energy Electrons (≥ 2MeV)

GOES16 High energy (>2MeV) Electron flux was at background to moderate levels, peak 960 pfu at 21/1440 UTC . With CME and CH HSS arrivals over the next few days, flux levels are expected to remain at largely background until later in the period, perhaps becoming diurnally high on 24 or 25 Mar.

MOSWOC REFM shows the electron fluence should remain below the Active threshold throughout the remainder of the period, and is considered reasonable guidance, albeit with low confidence as a slightly increasing trend towards the end of the period is possible.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	10	20
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 6: MOSWOC REFM fluence forecast/observations/recurrence.



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